

BEAM TRANSFER AND INJECTION SYSTEM (WBS 1.5)

i. Principal Characteristics and Parameters

The AGS will serve as the injector for RHIC. Filling RHIC initially with 56 bunches/ring will take about two minutes per RHIC cycle of five hours or more. The reference orbit of the AGS has a circumference of 807.12 m and its rf harmonic number is 12. The circumference of each RHIC ring is 19/4 that of the AGS and its harmonic number during injection is 360, the spacing between RHIC rf bucket centers being one-sixth of that in the AGS. The AGS will accelerate a variable number of bunches per pulse (4 heavy-ion bunches with the present booster rf system), and park them on an extraction orbit when the extraction energy ($\gamma \approx 26 \times Z/A$, with Z and A the charge mass and numbers) is reached. These bunches will be less than 17 nsec long; proton bunches will be shorter if bunch rotation in the AGS is used. The distance between bucket centers is 224.4 nsec in the AGS and 35.5 nsec in RHIC. The invariant emittance will be $<20\pi$ mm mrad for protons and 10π mm mrad for heavier ions. The AGS bunches circulate until they are transferred to one of the two RHIC rings, where they are received in designated buckets.

Ring selection is accomplished by means of a switching magnet, which can be reversed on the order of 1 sec, thus allowing a choice of RHIC ring filling scenarios. The rings are filled one bucket at a time, but can be filled sequentially or interleaved. Filling the rings sequentially only requires the switcher magnet to be reversed after the first ring is filled, however this procedure results in the first ring having stored bunches that are older than those in the second ring, and which may have suffered emittance growth. Interleaved filling will allow injection of a small number of bunches, e.g. four, in one ring followed by an equal number in the other ring, the switcher magnet being reversed between AGS cycles.

Injection into the RHIC rings will occur in the 6 o'clock insertion. The insertion quadrupoles are set for $\beta^* = 10$ m during the filling operation in all insertions in order to provide sufficient aperture. The AGS extraction kicker works in the horizontal plane, RHIC's injection kicker in the vertical one. Filling the buckets one by one allows filling every sixth bucket, or any other pattern, depending on the rise time of the injection kickers. The luminosity is proportional to the number of filled buckets per ring. Allowing for the upgraded operation, i.e., filling every third RHIC bucket for a nominal 2×112 bunches, requires the kicker filling time, including time jitter in the switches and other inaccuracies, to be less than 95 nsec. This may be contrasted with the risetime required for the

AGS extraction kicker, which must be ≤ 207 nsec (always assuming bunch lengths ≤ 17 nsec). Results of transfer line measurements are reported elsewhere.¹

¹T. Satogata et al. "Physics of the AGS-to-RHIC Transfer Line Commissioning", proceedings of the European Particle Accelerator Conference 1996, Stockholm, Sweden (1996).